



**UNITED STATES DEPARTMENT OF COMMERCE  
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
09/045,245	03/20/98	CHEN	L SMT4492P0020

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IM22/0317

EXAMINER

NICOLAS, W

ART UNIT

PAPER NUMBER

1741

6

DATE MAILED: 03/17/00

**Please find below and/or attached an Office communication concerning this application or proceeding.**

**Commissioner of Patents and Trademarks**

# Office Action Summary

Application No.

09/045,245

Applicant(s)

Chen

Examiner

Wesley Nicolas

Group Art Unit

1741



☒ Responsive to communication(s) filed on Jan 10, 2000

☒ This action is **FINAL**.

☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11; 453 O.G. 213.

A shortened statutory period for response to this action is set to expire 3 month(s), or thirty days, whichever is longer, from the mailing date of this communication. Failure to respond within the period for response will cause the application to become abandoned. (35 U.S.C. § 133). Extensions of time may be obtained under the provisions of 37 CFR 1.136(a).

## Disposition of Claims

☒ Claim(s) 1-69 is/are pending in the application.

Of the above, claim(s) 47 and 48 is/are withdrawn from consideration.

☐ Claim(s) \_\_\_\_\_ is/are allowed.

☒ Claim(s) 1-46 and 49-69 is/are rejected.

☐ Claim(s) \_\_\_\_\_ is/are objected to.

☐ Claims \_\_\_\_\_ are subject to restriction or election requirement.

## Application Papers

☐ See the attached Notice of Draftsperson's Patent Drawing Review, PTO-948.

☐ The drawing(s) filed on \_\_\_\_\_ is/are objected to by the Examiner.

☒ The proposed drawing correction, filed on Jan 10, 2000 is ☒ approved ☐ disapproved.

☐ The specification is objected to by the Examiner.

☐ The oath or declaration is objected to by the Examiner.

## Priority under 35 U.S.C. § 119

☐ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d).

☐ All ☐ Some\* ☐ None of the CERTIFIED copies of the priority documents have been

☐ received.

☐ received in Application No. (Series Code/Serial Number) \_\_\_\_\_.

☐ received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

\*Certified copies not received: \_\_\_\_\_

☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

## Attachment(s)

☐ Notice of References Cited, PTO-892

☐ Information Disclosure Statement(s), PTO-1449, Paper No(s). \_\_\_\_\_

☐ Interview Summary, PTO-413

☐ Notice of Draftsperson's Patent Drawing Review, PTO-948

☐ Notice of Informal Patent Application, PTO-152

--- SEE OFFICE ACTION ON THE FOLLOWING PAGES ---

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### **DETAILED ACTION**

This is in response to the Amendment dated January 10, 2000. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

Claims 1-69 are currently pending in this application. Claims 47-48 have been withdrawn from consideration as being drawn to a non-elected invention as set forth in Paper No. 3.

#### **Election/Restriction**

1. This application contains claims 47-48 drawn to an invention non-elected with traverse in Paper No. 3. A complete reply to the final rejection must include cancellation of non-elected claims or other appropriate action (37 CFR 1.144) See MPEP § 821.01.

#### **Drawings**

2. The proposed drawing correction and/or the proposed substitute sheets of drawings, filed on January 10, 2000, have been **approved** by the Examiner.

#### **Specification**

3. The objections to the specification as stated in the previous Office action have been **withdrawn** in view of Applicant's amendment dated January 10, 2000.

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**Claim Rejections - 35 USC § 112**

4. The 35 U.S.C. § 112, first paragraph rejections as set forth in the previous Office action have been **maintained** and are incorporated herein. A rebuttal to the arguments made by Applicant can be seen below in the "REMARKS" section.

5. Claims 1-46 and 49-69 are rejected under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. In this case, Applicant has added the phrase "microelectronic" or "micro-sized metal structures on a microelectronic workpiece" to the claims and Examiner is unsure where support for said terms is in the specification. Examiner contends that the term "microelectronic" is broader in scope and covers more items than just "semiconductor" as previously claimed. Applicant is encouraged to point out where support for said terms can be found in the disclosure in order to overcome this rejection.

In addition, the term "demascene" as set forth in new claim 63 appears to be a new term used by Applicant. This term has a specific meaning in the art and Applicant should point out in the disclosure where support can be found.

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6. The 35 U.S.C. § 112, second paragraph rejections as stated in the previous Office action have been **withdrawn** in view of Applicant's argument and amendment dated December 23, 1999.

**Claim Rejections - 35 USC § 102**

7. Claims 1-3, and 7 rejected under 35 U.S.C. 102(b) as being anticipated by Farooq et al. (5,549,808).

The rejection of claims 1-3, and 7 has been **withdrawn** in light the argument and amendment made by Applicant in the paper dated January 10, 2000. A new rejection is indicated below.

8. Claims 16 and 17 are rejected under 35 U.S.C. 102(b) as being anticipated by Dubin et al. (5,882,498).

The rejection of claims 16-17 has been **withdrawn** in light the argument and amendment made by Applicant in the paper dated January 10, 2000. A new rejection is indicated below.

**Claim Rejections - 35 USC § 103**

9. Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over Farooq et al. (5,549,808) as applied to claim 1 above.

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The rejection of claim 6 has been **maintained** and is as set forth in the previous Office action dated July 9, 2000 which is incorporated herein.

10. Claims 4-5, 8-10, 12 and 14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Farooq et al. (5,549,808) as applied to claim 1 above, and further in view of Gilton et al. (5,151,168).

The rejection of claim 8 has been **withdrawn** in light of the indication of allowable subject matter below.

The rejection of claims 4-5, 9-10, 12 and 14 has been **maintained** and is as set forth in the previous Office action which is incorporated herein.

11. Claims 30-34, 35-40, 42 and 45 are rejected under 35 U.S.C. 103(a) as being unpatentable over Farooq et al. (5,549,808), and further in view of Gilton et al. (5,151,168).

The rejection of claims 33-34 has been **withdrawn** in light of the indication of allowable subject matter below.

The rejection of claims 30-32, 35-40, 42 and 45 has been **maintained** and is as set forth in the previous Office action which is incorporated herein.

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15. Claims 9, 11, and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Farooq et al. (5,549,808) as applied to claim 1 above, and further in view of Makkaev et al. (4,576,689).

The rejection of claims 9, 11, and 13 has been **maintained** and is as set forth in the previous Office action which is incorporated herein.

16. Claims 41, 43, and 44 are rejected under 35 U.S.C. 103(a) as being unpatentable over the Farooq et al.- Gilton et al. combination as applied to claim 30 above, and further in view of Makkaev et al. (4,576,689).

The rejection of claims 41, and 43-44 has been **maintained** and is as set forth in the previous Office action which is incorporated herein.

#### **Rejection of Amended or Newly Added Claims**

17. Claims 1-3, 7, 49, 53, 59 and 64, 67-69 are rejected under 35 U.S.C. 103(a) as being unpatentable over Farooq et al. (5,549,808).

Farooq et al. are as applied, argued, and disclosed above and incorporated herein and further disclose the formation of an interconnect structure wherein an ultra-thin seed layer is formed on a barrier layer, said ultra-thin seed layer having a thickness of about 500 Å, and then

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12. Claims 15 and 46 are rejected under 35 U.S.C. 103(a) as being unpatentable over Farooq et al. and Gilton et al. as applied to claims 14 and 45 above, and further in view of Dubin et al. (5,882,498).

The rejection of claims 15 and 46 has been **maintained** and is as set forth in the previous Office action which is incorporated herein.

13. Claims 18-23 and 27-29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dubin et al. (5,882,498) as applied to claim 16 above, and further in view of Gilton et al. (5,151,168).

The rejection of claims 18-23 and 27-29 has been **maintained** and is as set forth in the previous Office action which is incorporated herein.

14. Claims 24-26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dubin et al. in view of Gilton et al. as applied to claims 16-17, and 20 above, and further in view of Makkaev et al. (4,576,689).

The rejection of claims 24-26 has been **maintained** and is as set forth in the previous Office action which is incorporated herein.



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enhancing the ultra-thin seed layer by depositing a metal such as copper by electroplating (col. 4, lines 10-26).

Farooq et al. fail to specifically teach a thickness of the ultra-thin metal seed layer of less than 500 Å or the specific coverage of the enhancement to the seed layer. Farooq et al. also fail to disclose the subsequent plating of the enhanced ultra-thin seed layer or the specific coverage in relation to the nominal thickness of the enhanced seed layer.

Claims 1, 49, and 67 are rejected because it would have been obvious and within the skill in the art at the time the invention was made to have specified the enhanced seed layer thickness because the specific thickness would have been considered a result effective variable by one having ordinary skill in the art. As such, one having ordinary skill would have routinely optimized the thickness of the enhanced ultra-thin seed layer to obtain the purification benefits attendant therewith. In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980). In re Aller, 105 USPQ 233.

Although Farooq et al. is silent with regards to additional layers on top of the enhanced ultra-thin seed layer, claims 64, and 67-69 are rejected because it would have been obvious and within the skill in the art at the time the invention was made to have added additional layers because the addition of layers is merely seen as a duplication of parts which would have been dependent on the intended use of the substrate. It has been held that mere duplication of parts has little patentable significance unless new and unexpected results are produced. In re Harza, 274 F.2d 669, 124 USPQ 378 (CCPA 1960).

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Claim 2 is rejected because Farooq et al. teach that the enhancement to the ultra-thin seed layer is made using copper (col. 4, lines 10-26).

Claims 3, 53 and 59 are rejected because Farooq et al. teach that the enhancement of the ultra-thin metal seed layer is done using an electrochemical deposition step (col. 4, lines 10-26).

Claim 7 is rejected because Farooq et al. disclose that the thickness of the ultra-thin seed layer is about 500 Å thick (0.05 μm) (col. 4, lines 10-26).

18. Claims 16-17 and 63 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dubin et al. (5,882,498), and further in view of Farooq et al. (5,549,808).

Dubin et al. is as applied, argued, and disclosed above and incorporated herein and further teach a means for applying a conductive ultra-thin layer to the surface of a semiconductor workpiece, and a means for electrochemically enhancing the conductive ultra-thin seed layer (col. 3, line 50 to col. 4, line 56). Dubin et al. also disclose that the means for applying the ultra-thin copper seed layer is applied onto a barrier layer on the surface of the semiconductor (col. 4, lines 1-3).

Farooq et al. <sup>or</sup> ~~is~~ as applied, argued, and disclosed above and incorporated herein.

Dubin et al. do not disclose the deposition of an ultra-thin seed layer with a thickness of less than 500 Angstroms.

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Claims 16-17, and 63 are rejected because it would have been obvious and within the skill in the art at the time the invention was made to have used the apparatus of Dubin et al. to form a layer with a thickness of about 500 Angstroms as taught by Farooq et al. because Farooq et al. teach of a thin seed layer which enables very small and efficient interconnects.

19. Claims 51-52, 54-58, 60-62, and 66 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dubin et al. (5,882,498) as applied to claims 49 and 50 above, and further in view of Gilton et al. (5,151,168).

Dubin et al. <sup>are</sup> ~~is~~ as applied, argued, and disclosed above and incorporated herein.

Gilton et al. <sup>are</sup> ~~is~~ as applied, argued, and disclosed above and incorporated herein.

Dubin et al. do not disclose the specific CVD or PVD layer application.

Claims 51 and 57 are rejected because it would have been obvious and within the skill in the art at the time the invention was made to have used the sputtering process of Gilton et al. in the invention of Dubin et al. because Gilton et al. teach of the sputtering of metal layers and sputtering is well known in the art to be a common PVD process which provides conformal coatings without the contamination brought about by CVD processes (col. 4, lines 53-65).

Claim 52 and 58 are rejected because it would have been obvious and within the skill in the art at the time the invention was made to have used the CVD process of Gilton et al. in the invention of Dubin et al. because Gilton et al. teach that CVD produces layers with high

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conformality which ensures a more uniform surface coating (col. 4, lines 53-65). Although Gilton et al. disclose that the CVD process is used to deposit the barrier layer, it is the overall structure (i.e. means for applying CVD coating) that is material, not the specific method steps.

Claims 54 and 60 are rejected because it would have been obvious and within the skill in the art at the time the invention was made to have used the complexing agent of Gilton et al in the invention of Dubin et al. because Gilton et al. disclose a complexing agent such as EDTA prevents the metal ions from precipitating out of solution thereby increasing the efficiency of the process (col. 3, line 54). In addition, it would have been obvious and within the skill in the art at the time the invention was made to have used the alkaline bath of Gilton et al. in the invention of Dubin et al. because when depositing at lower pH values, the metal is more coarsely grained which results in an irregular surface coating (col. 3, lines 59-60) and an increase in surface area. Also, Gilton et al. disclose the complexing agent EDTA in a concentration of between 0.02 and 0.14 molar (col. 5, lines 20-21), which overlaps Applicant's claimed range. When general conditions are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by changing the size, shape, proportion of shape, degree and sequence of added ingredients through routine experimentation. See for example In re Rose, 105 USPQ 137; In re Aller, 220F, 2d 454, 105 USPQ 233, 235 (CCPA 1955); In re Dailey et al., 149 USPQ 47; In re Reese, 129 USPQ 402; In re Gibson, 45 USPQ 230. In this case, the specific range would have been dependent on the voltage, temperature, and ionic strength of electrolytic bath, and the desired coating on the substrate.

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Claims 55-56 and 61-62, and 66 are rejected because it would have been obvious and within the skill in the art at the time the invention was made to have included a rinsing step as disclosed in Dubin et al. (Dubin et al. disclose spinners and polishers which comprise a rinsing step (col. 5, lines 55-65)), because it is well within the skill in the art to keep semiconductor workpieces clean and free of dust particles as evidenced by the well known semiconductor "clean rooms". In addition, it is well known in the art that the CUBATH® used by Dubin et al. is an acid copper electroplating bath.

20. Claim 65 is rejected under 35 U.S.C. 103(a) as being unpatentable over Farooq et al. (5,549,808), and further in view of Gilton et al. (5,151,168).

Farooq et al. <sup>are</sup> ~~is~~ as applied, argued, and disclosed above and incorporated herein.

Gilton et al. teach the use of an alkaline electroplating bath and the use of a complexing agent (Abstract).

Farooq et al. do not teach plating in an alkaline bath or the use of a complexing agent.

Claim 65 is rejected because it would have been obvious and within the skill in the art at the time the invention was made to have used the alkaline bath of Gilton et al. in the invention of Farooq et al. because when depositing at lower pH values, the metal is more coarsely grained which results in an irregular surface coating (col. 3, lines 59-60) and an increase in surface area.

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**Allowable Subject Matter**

21. Claims 8, 33, 34, 50 are objected to as being dependent upon a rejected base claim, but would be allowable if 35 U.S.C. 112 issues are cleared up **and** rewritten in independent form including all of the limitations of the base claim and any intervening claims.

22. The following is a statement of reasons for the indication of allowable subject matter: The specific size range of less than about 250 Angstroms for the ultra-thin layer was not taught or suggested by the prior art of record. In addition, Applicant shows comparative results to the specific size criticality.

**REMARKS - Response to Arguments**

23. Applicant's arguments filed January 13, 2000, have been fully considered but they are not persuasive.

Applicant asserts that there are no deficiencies in the claims with regards to 35 U.S.C. 112, first paragraph. Applicant contends that since there are many deposition methods known in the art, that the claim is open to all of such methods and therefore is adequately enabled. Furthermore, Applicant contends that an adequate disclosure of the deposition of the seed layer carries over to the methods of enhancing the ultra-thin seed layer and therefore said methods are implied. In response, Examiner must respectfully disagree. Applicant ONLY discloses electrochemical deposition process for enhancement of the ultra-thin seed layer and as such, the

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specification is not enabling for any other deposition method. Although other known deposition methods exist, it is not correct to imply methods that aren't specifically disclosed and in effect, Applicant is claiming more broadly than what is enabled by the disclosure. It is clear that in this respect that the claims suffer from 35 U.S.C. 112, first paragraph deficiencies.

With respect to the prior art of record, Applicant submits that the Farooq et al. reference cannot be used against claims that specifically recite ultra-thin seed layers of **less than** 500 Angstroms. In response, Examiner contends that the phrase "about" as shown on col. 4, line 17 is enough to read on thicknesses of less than 500 Angstroms. As such, the Farooq et al. reference has not been withdrawn and is used in the rejections as set forth above.

In regards to Applicant's arguments on page 23 of the response, specifically the bold section, Applicant contends that independent claims 1, 58 and 67 to not teach or suggest "the enhancement of an ultra-thin seed layer having a thickness that is less than or equal to about 500 Angstroms where the seed layer is ultimately used to **electroplate** a metal in micro-recessed structures...". In response, Examiner is not aware of any independent claim 58 in the file and further, electroplating is not positively claimed in any one of claims 1, 58, or 67 and as such, the argument is not commensurate in scope with the referenced claims.

Applicant asserts that the Farooq et al. ('808) reference does not apply to the instant invention because the chromium layer does not function in the capacity of a "seed" layer. In response, Examiner has not made any remarks noting that the chromium layer acts as a seed layer. As Applicant pointed out in their argument on page 22, as well as what is disclosed in Farooq et

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al. on col. 4, lines 10-26, the chromium layer is intended to be a barrier layer between the copper and the substrate to prevent migration of copper into the board. Farooq et al. specifically disclose that a seed layer of copper is laid on top of the seed (barrier) layer and that is the "seed" layer in which Examiner refers to in the rejection(s).

Applicant further asserts that the '808 reference does not teach enhancement of the seed layer prior to bulk electroplating. In response, Examiner must partially agree and partially disagree with this argument. First, Farooq et al. clearly teaches enhancement of the copper seed layer by saying in column 4, lines 10-26, "Typically, copper 18, is deposited, such as by electroplating...", said copper layer overlying the first copper "seed" layer. With regards to the "bulk electroplating" after the enhancement, Farooq et al. fails to specifically disclose such a limitation but an obvious rejection is set forth above.

In regards to the utilization of the '498 reference of Dubin et al., Applicant asserts that Dubin et al. does nothing to disclose the enhancement of the ultra-thin seed layer prior to bulk electroplating. In response, Examiner reads "enhancement" as being equivalent if not identical to "bulk electroplating" because Applicant has done nothing in the claims to distinguish the two from each other. As such, even though Dubin et al. fails to disclose the desired seed layer thickness, the reference, when combined with others makes it applicable as a reference because of the teachings directly associated with Applicant's field of endeavor.



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*Conclusion*

24. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the mailing date of this final action.


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25. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Wesley Nicolas whose telephone number is (703)305-0082. The examiner can normally be reached on Mon.-Thurs. from 7am to 5pm.

The Supervisory Primary Examiner for this Art Unit is Kathryn Gorgos whose telephone number is (703) 308-3328.

The fax number for this Group is (703)305-7719.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703)308-0661.

  
Kathryn Gorgos  
Supervisory Patent Examiner  
Technology Center 1700

Wesley Nicolas

March 16, 2000